Photograph 1. Looking downstream from Highway 77.

Photograph 2. Looking upstream from the BNSF railroad bridge toward Pioneers Boulevard.

Stream Segment Evaluation

Stream Segment 1

Stream Segment 1 includes the reach of Beal Slough from its mouth at Salt Creek in Wilderness Park to Highway 77.

Reach Stability - The reach from the mouth to the Union Pacific Railroad (UPRR) and Burlington Northern Santa Fe Railroad (BNSFRR) bridges has experienced 2 to 3 feet of bed degradation since 1978. From Pioneers Boulevard bridge to 500 feet upstream, the channel banks have migrated between 10 and 20 feet on the outside radius due to sloughing. The banks are steep and unstable, most likely due to the bed degradation. Near the mouth, a meander on Salt Creek and a meander on Beal Slough are moving toward each other. Salt Creek has migrated and taken over the last 500 feet of the Beal Slough channel.

Flood Hazard Potential - The Salt Creek floodplain controls the floodplain water surface elevation from the mouth to the railroad bridges. Between Pioneers Boulevard and Highway 77 water surface elevations have increased due to the increased flow rate conveyed by the stream.

Threats to Bridges & Utilities - Unstable banks due to a scour hole near station 55+00 threaten an electrical transmission tower. Channel degradation has exposed the timber piling supporting the Pioneers Boulevard bridge, which is listed as an historic structure.

Land Use and Ownership - Public lands lie on either side of the channel downstream of the railroad bridges. Between the railroad bridges and Highway 77 there is one residence. The remainder of the land use is identified as industrial and commercial.

Multipurpose Potential - Multipurpose use potential is limited outside the boundaries of Wilderness Park.

Water Quality - Parking lot and roof top runoff from adjoining industrial and commercial land use is the dominant characteristic affecting runoff water quality and environmental issues. Bank sloughing is a significant source of sediment in this reach. Bars formed in the channel are the result of sediment deposition from upstream sources. In 1997, a stream water quality monitoring location was established near the mouth. Water samples in this reach have been collected and analyzed, but evaluation by the City is not complete.

Photograph 3. Looking Upstream from Highway 77.

Photograph 4. Looking downstream from the 27th Street box culvert.

Stream Segment Evaluation
Stream Segment 2

Stream Segment 2 includes the reach from the Highway 77 bridge to the box culvert at 27th Street and is crossed by a railroad spur and Southwood Drive.

Reach Stability -	Erosive velocities are evident at the end of the 27th Street box culvert outlet channel. Head cutting is occurring at the railroad spur bridge near Station 90+00. The stream bed grade between Highway 77 and the railroad spur bridge is approximately equal to the stable slope determined for Beal Slough. The Southwood Drive culvert flow line elevation is currently 3 feet above the stream bed elevation for the same point on the FIS stream bed profile, indicating that the stream bed has degraded at this location. The channel slope from Southwood Drive to 27th Street is at or flatter than the stable slope. The box culverts serve as control points for this reach at the upstream and downstream ends. Channel banks are sloughing on the outside radii of meanders due to toe cutting.
Flood Hazard Potential -	Buildings constructed in the floodplain prior to the FIS are subject to flooding. Buildings constructed after adoption of the FIS may also be subject to flooding from the increased water surface elevation.
Threats to Bridges & Utilities -	A sanitary sewer crossing was exposed near station 66+00 upstream of Highway 77 (It was repaired at a cost of $60,000 in 1999). The head cut moving upstream from Station 90+00 will likely result in 3 to 4 feet of additional bed degradation threatening the railroad spur bridge. (If allowed to move beyond the railroad spur, it may eventually reach Southwood Drive cut nearly 10 feet deep at the culvert.)
Land Use and Ownership -	Commercial and industrial land uses occur along the downstream portion of this segment. The upstream portion of this segment is bordered on both sides by a public park.
Multipurpose Potential -	Unstable banks present safety concerns to users of the park. The encroachment of development in the downstream portion restricts additional multi-use potential of this segment.
Water Quality -	Parking lot and roof top runoff from adjoining industrial and commercial land use is the dominant characteristic effecting water quality and environmental issues. Bank sloughing is a source of sediment in this reach. Refer to the Water Quality Section for data collected at the NPDES monitoring sites discharging into this stream segment.

EVALUATION SUMMARY

STORMWATER QUALITY

Urban Runoff

Evaluation of water quality samples collected by the City at five Lincoln sites indicates that stormwater quality within the City appears to be relatively good compared to national runoff quality data. The five monitoring sites are located in basins selected by the Public Works Department to collect runoff data from typical watersheds. Two sites are in predominately residential watersheds, two are in watersheds with predominately industrial land use, and one is in a predominantly commercial watershed. The commercial site and one of the residential sites are located in Beal Slough. There does not appear to be any trend indicating an improvement or impairment of stormwater quality. Available data indicates the parameters most frequently observed at elevated concentrations include TSS, COD, oil and grease, and nutrients. The high concentrations observed for several parameters in 1993, may in part, be explained by the heavy rains and local flooding that occurred at that time in the region. See Appendix C - Comparison of Lincoln Stormwater Quality with National Urban and Denver Metropolitan Data.

Erosion and Sedimentation in Streams

In 1997, storm runoff samples from eight locations along Beal Slough were evaluated by the City for Oil and Grease, Total Suspended Solids (TSS) and Total Dissolved Solids (TDS). National average values for TDS were not available from the National Urban Runoff Pollutants (NURP) study. Values for Oil and Grease found in stream flows in Beal Slough were below the national average, but values for TSS found on stream flows in Beal Slough are greater than the national average. TSS is indicative of the sediment load in streams. Sources for suspended solids include tire rubber and winter sanding operations, but the largest source is eroded soil. Based on field observations, stream bank and bed erosion contributes a substantial amount of suspended solids in Beal Slough. Improving bed and bank stability would reduce the amount of soil eroding and entering the stream. Reducing the amount of soil entering the stream would improve the quality of water conveyed downstream by Beal Slough.

The Beal Slough channel continues to grow wider and deeper as the watershed urbanizes. As stormwater rushes through the channel, it takes with it soil from along the banks which adds to the suspended solids problem. This erosion has led to a dramatic increase in channel width and depth that is evident when comparing aerial photographs from 1940 to those flown in 1997. In 1940, the channel widths in the lower reaches of Beal Slough were between 6 and 9 feet compared to widths between 45 and 65 feet wide today.

It is estimated that approximately 200,000 cubic yards of soil have eroded from the Beal Slough channel reach between Salt Creek and Old Cheney Road in the past 25 years -- the equivalent of 12,000 dump truck loads. This information was based on a comparison of channel cross-sections surveyed for the 1978 FIS with surveys conducted at the same locations in 1997, see Figure I-12. The comparison revealed the following:

- Between Salt Creek and Highway 77, an average of two dump truck loads of soil has eroded from each foot of channel.
- Between 27th Street and Highway 2 near 38th Street nearly 10 cubic yards of soil has eroded from each foot of channel.

Evaluation of original and current ground lines at a sanitary sewer crossing installed in 1966 downstream of Highway 77, near the Penitentiary, indicates substantial channel degradation. Originally there was 6 feet of cover above the pipe. In January 1997 the Public Works and Utilities Department spent $100,000 to repair the sewer crossing because 20 feet of pipe was exposed and the streambed was 2 feet below the sewer.

The deeply incised channel in the lower and middle reaches of Beal Slough today stems from changes to the Beal Slough channel alignment made in the 1930s as a result of Salt Creek channel degradation induced by channel straightening, and increased flow rates from urbanization since the mid-1960s. Channel banks must be stabilized and flow rates controlled in the upper reaches of Beal Slough or the banks will resemble the deeply incised channel found in the lower and middle reaches of Beal Slough.

Erosion and Sediment from Land Disturbance Activities

Construction sites in the basin are another significant source of erosion and sediment. Even though management of construction site erosion and sediment is currently required by City, State, and Federal law, erosion and transfer of sediment and related pollution to downstream properties and receiving waters is largely uncontrolled. Eroded material also carries other pollutants which attach to soil particles. This stormwater issue can best be addressed through implementation of city and NRD standards outlined in the Lincoln Stormwater Drainage Criteria Manual.

STORMWATER QUANTITY

Localized Flooding

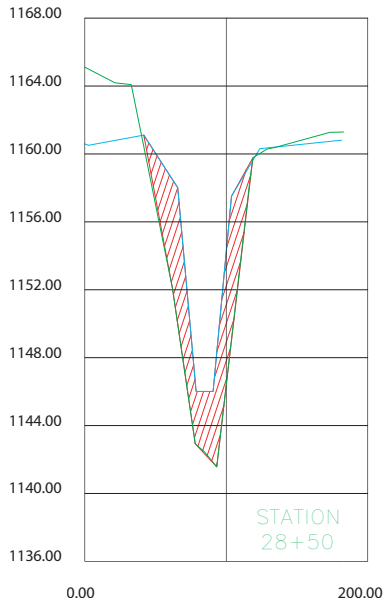
Localized flooding problems within the basin are mostly due to increased runoff from urbanization that causes damage because overflow routes to channels and streams are inadequate in capacity. Planning, implementing and protecting major storm overflow routes can prevent a majority of future localized flooding problems in new developments. The Lincoln Stormwater Advisory Committee recommended changes to stormwater policies and ordinances to require determination of overland flow routes through new developments and preservation of those routes with easements if they are not along public right-of-way. Improved public awareness of stormwater issues will also be beneficial.

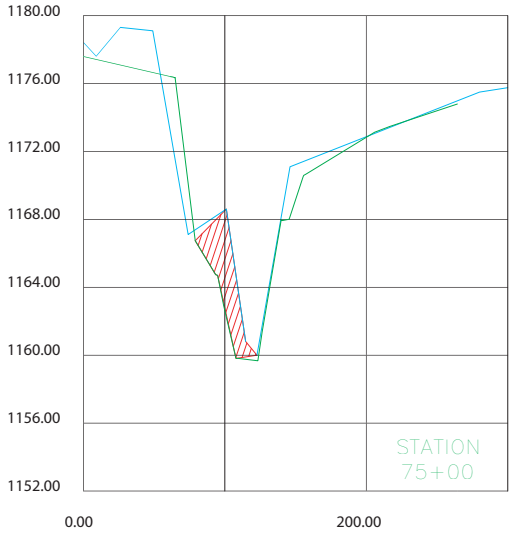
Flooding Along Streams and Channels

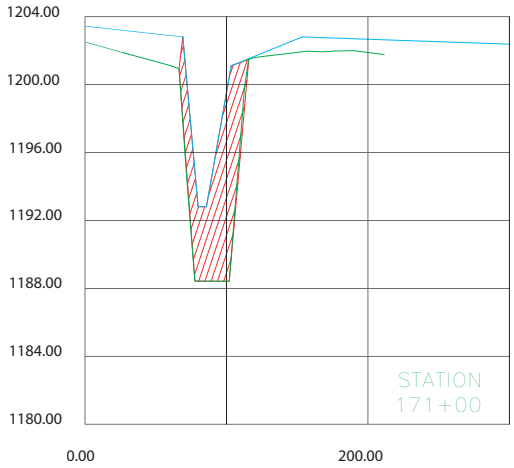
Beal Slough basin was approximately 40% urbanized in 1978, today the urbanized area is nearly double the size it was then. Peak rates of flow along Beal Slough are 30% to 80% greater than FIS values based on 1978 conditions. The growth in peak flow rates results in more frequent bridge and channel overtopping. Overloading of these stormwater facilities necessitates premature replacement or augmentation with additional capacity. Enforcement of regulations for development in the FEMA 100-year flood plain has prevented flood damage to buildings constructed along Beal Slough after 1978, but development has occurred along tributaries to Beal Slough that were not included in the FEMA 100-year flood plain. Many homes and businesses constructed along tributary channels are exposed to flood hazards. Refer to Table I-13, 100-year Peak Flow Rate Comparision. Refer to Table I-10, 100-year

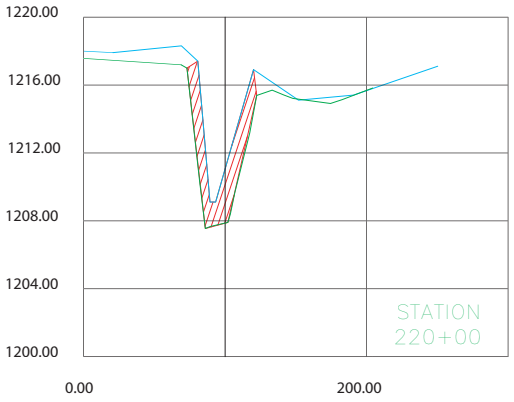
Based on hydrology and hydraulics analyses performed for this Master Plan, flood prone areas along tributaries to Beal Slough have been mapped and are shown on Figures SG1-FP through SG16-FP. Any future development along the tributaries should be done in a manner to avoid encroachment of and damage from these flood hazards.

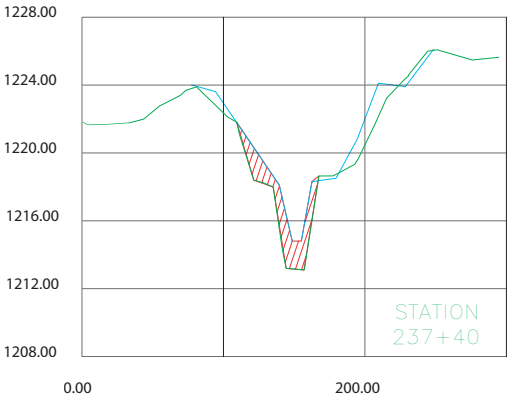
Measures to reduce 2-year flow rates to historic values in the mainstem channel downstream of developed areas and to preserve existing 2-year flow rates in the mainstem downstream of undeveloped areas would reduce the erosive forces improving stability of the channel bed and banks.











LEGEND

MATERIAL LOST TO EROSION FROM 1978 TO 1998

1978 GROUND SURFACE

1998 GROUND SURFACE

6/8/1999 8:57 P.M. FILE: F:\Projects\960282\dwg\plsec.dwg SCALE: 100

DRAWN BY: JJM
DATE: JUNE 1999
REVISIONS:

BEAL SLOUGH MASTER PLAN

LINCOLN, NEBRASKA

CHANNEL CROSS-SECTION
COMPARISON BETWEEN FIS 1978 AND 1998

FIGURE I-12

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